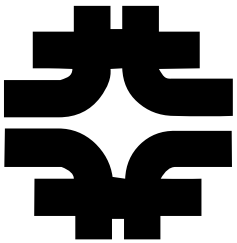
On Transverse Emittance Dilution due to Multiple Scattering in TeV Flying Wire



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Do we significantly degrade the transverse emittance by flying the wire in TeV?

- Moliere Prediction:
  - ~ 0.7 % per fly, for 3 wires, two passes through the beam.
  - Caveats of the calculation.
- Observation: Emittance blow-up is smaller than predicted, by factor 2 to 3.
  - But we scrape the beam ! Yes, but not immediately after flying the wire!
- Conclusion: No evidence in the data that this is a serious problem, yet. However, we should check by not flying the wire “that often” during injection.

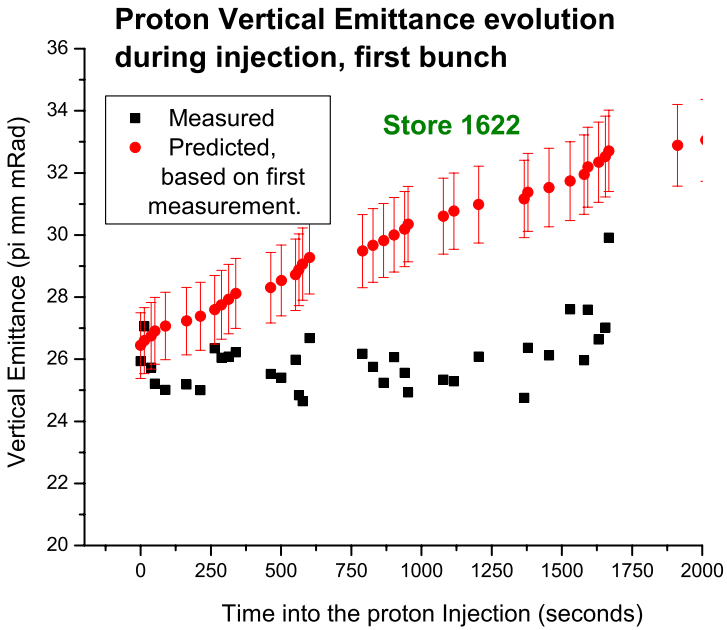
Moliere Based Calculation.

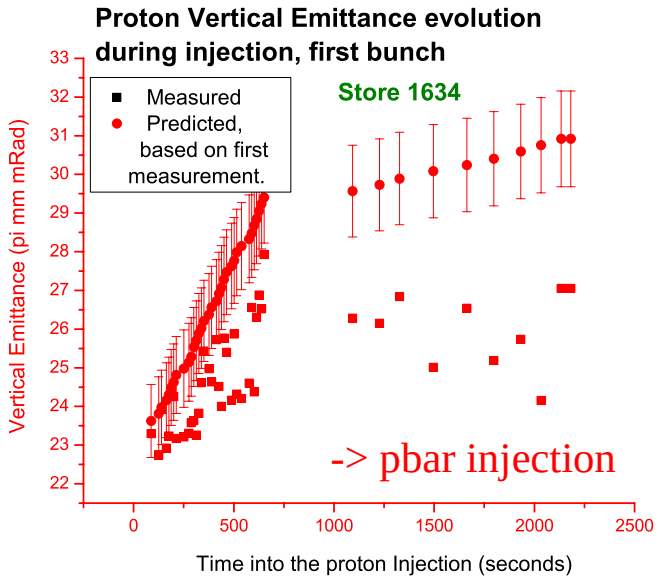
- 1: compute x' from emittance. Assuming 20 pi, for β = 80 m, (α = 0.), E = 150 GeV, …. σ x' ~ 16 μRad
- 2 : σ x' due to Multiple Scattering:
  - Wire is 30 micron diameter => average thickness is 19 micron. ➔ L/R = 0.0001 (Carbon is the material, Lr = 18.8 cm)
  - Every turn, wire move transversely by 75 μ. For a beam much wider than ~10 m, only ~40% of the beam sees the wire. For this fraction of the beam, per pass, per wire, $\sigma x'_{MS}$ = 0.9 μRad.
- 3 .. Emittance dilution = $\sigma x'^2 / (\sigma x'^2 + \sigma x'^2_{MS})$ = 0.13% per fly per pass per wire.=> .76 % total.

Moliere Caveats:

- The usual PDG formula based on the Moliere scattering is invalid for radiation length < .1%!, which 10 times less than the wire.
- Can't simply add the passes/wires: the angles get randomized in between passes!
- Moliere is probably an overestimate!

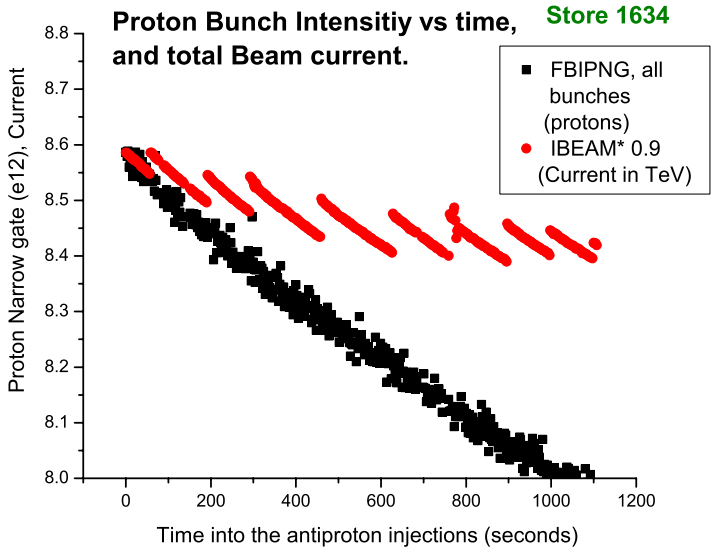
Proton Vertical Emittance, bunch 1

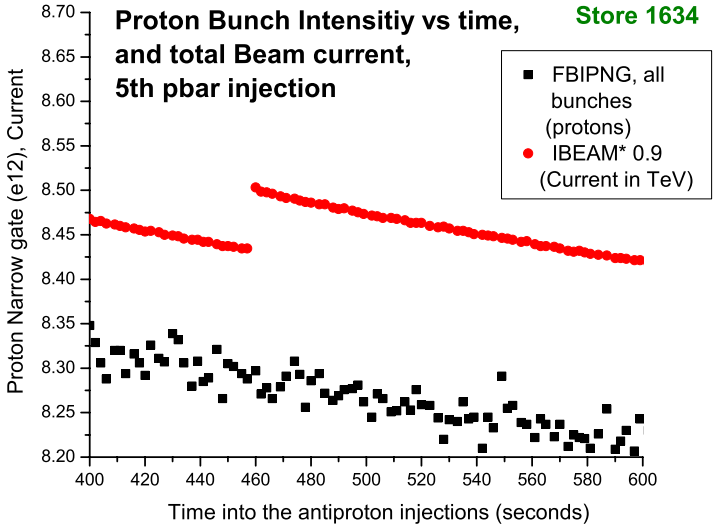




Error are based on a 4% relative error bar on the measured emitance at ~t=0. (first injection). => We do not observe such a large emitance blow-up , over 2 store, on central orbit or on the helix.

But we scrape the beam! May be we reached some aperture, the emittance can't grow.





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Conclusion

- No evidence in the data that flying the wire dilutes the emittance signficantly.
- For such thin absorbers, not easy to estimate.
- No urgency, we should still measure this!.